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TYPE DESIGNATION AND STANDARDIZATION IN HEAVY-MACHINE BUILDING

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The output of heavy machinery had more than doubled in the USSR by the end of 1949 in comparison with the 1946 figure, and had surpassed the 1940 output by 69 percent. Production of cranes was more than doubled, that of steam boilers and locomobiles increased 2.6 times, output of metallurgical and petroleum-industry equipment was nearly tripled. Oil-drilling and general petroleum-industry equipment had been produced in such quantity as to free the country from the need of importing it. By January 1950, the Ministry of Heavy-Machine Building had attained the average monthly level of production set for the year 1950.

Changeover to series production has been the most important factor in raising the output of heavy machinery. The key to success in this production system lies in extensive standardization of parts and units; that is, manufacture of identical parts and units for machines of the same type, but of different dimensions, and in some cases, for machines which differ completely from one another.

Up to now, the greatest successes in this field have been attained in the turbine-building industry, with the USSR being the first country in the world to establish national standards for steam turbines.

In 1943, standardization in construction of steam turbines was greatly accelerated. Shortly after the end of the war, the Leningrad Metal Plant imeni Stalin produced a series of six steam turbines: high-pressure condenser turbines of 100,000-, of 50,000-, and of 25,000-kilowatt capacity at 3,000 revolutions per minute; high-pressure turbines of 25,000-kilowatt capacity, the first having one, and the second, two regulated steam take-offs; and a normal-pressure turbine of 25,000-kilowatt capacity with an industrial take-off. The degree of standardization for the series constituted a new record in turbine building, 80 percent of the units, and 70 percent of the individual parts.

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In the manufacture of blades, the plant achieved standardization in the size of the blade roots and blade cross-section, and to a considerable degree, in the length of the blades. There was broad standardization of diaphragms, also; a number of identical diaphragms are now installed in various types of turbines.

All turbines of the series have identical cylinders for the high-pressure sections. Forward bearings, and a considerable number of the parts of the steam-distributor assemblies are identical for all turbines of the series, and standardization of the labyrinth packing is extensive.

The extent to which the regulator assemblies were standardized is remarkable, in view of the fact that they were incorporated into such widely differing turbines.

In the hydroturbine field, a range of type-sizes (tiporazmer) has been developed to answer the demands of power stations as to capacity and pressure. Standardized units and parts going into their construction amount to 40 percent by weight. As a result of this standardization, the number of type-sizes of units and parts going into their construction was one sixth of the number required under individual construction, and one twentieth of that number for some of the type-sizes of units and parts.

Designers at the Khar'kov Turbogenerator Plant imeni Kirov developed a series of standardized high-pressure turbines, comprising condenser turbines of 100,000- and 50,000-kilowatt capacity (VK-100 and VK-50), and 25,000-kilowatt capacity turbines (VP-25-1 and VP-25-2).

In standardizing turbocompressor parts at the Leningrad Nevskiy Plant imeni Lenin, it was kept in mind that the productivity and pressure of turboblowers, turbocompressors, and analogous units, sharply changes with a change in the size of the rotor, while there is little change in the productivity and pressure when the size of the stator is changed. Thus standardization could be applied to those parts of the machines requiring the most work -- the outer body and diaphragms.

Five heavy blast-furnace blowers, having a productivity of 2,000 to 4,000 cubic meters per minute, were made with identical intake chambers, diaphragms, and bearings, and only two types of discharge chambers. In addition to standardization of the stator elements, there was partial standardization of elements of the rotors. The working wheels of the 2,000-cubic-meter-per-minute air blower, and those of the 4,000-cubic-meter-per-minute model are identical. The overall standardization for the heavy blower series ranged from 73 to 92 percent.

Standardization was also instituted for machines of low productivity (450 to 750 cubic meters per minute). In spite of the completely different uses of these machines (exhaust fans and gas blowers) and the different gases on which they are used (coke, shale), standardization was achieved in four types of machines.

The main bodies of the two-stage and three-stage machines of this series were standardized by applying the combination, or built-up principle in their construction. The different models were built by adding removable elements, according to the length of the frame. This combination system will be of basic importance in solving future problems of standardization.

The Nevskiy Plant imeni Lenin is applying principles of standardization in the construction of steam turbines and boosters.

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Standardization will be applied by the Kaluga Turbine Plant in producing new turbines of 2.5-, 4-, and 6-megawatt capacity. These turbines, in conformity to the standard, will comprise 21 type-sizes of various uses. The designing of all type-sized of this series will be done simultaneously, standardizing the basic elements in the plans of each machine. Thus, only eight type-sizes of stages will be required in building 12 type-sizes of turbines in the series. Six of these type-sizes will have common cross-sections for both rotor and stator blades and blade roots, with blades differing only in length.

Standardization was broadly applied at the Ekonomayzer Plant in the construction of two series of heavy turbopumps of normal and high pressure, (PT-35 and RVPT-29), designed to pump feed water in power stations.

Series PT-35, comprising nine type-sizes, is built around three standardized types, having up to 70 percent interchangeable parts. Series RVPT-29, comprising 12 type-sizes, is built around a single aggregate, 95 percent standardized.

In spite of serious difficulties, standardization is going ahead in boiler construction. Since the war, efforts have been made to limit the range of standardized boiler aggregates suitable for varied fuels. An All-Union state standard was worked out for the parameters of steam and productivity of boiler aggregates in conformity with the standard for steam turbines. Power-plant boiler aggregates were standardized in their basic elements.

Now the adaptation of a standardized aggregate to different kinds of fuel is being effected by partial modifications of the superheater and the rear surfaces, while the basic elements -- the steam drums, the frame, separator devices, generator tubes, and other units -- are not changed. Mountings, fittings, supports, heating-tube diameters, economizers, and air heaters, have been standardized.

In 1947-48 the PK-9 steam-generating boiler aggregate, having a capacity of 200 tons per hour at 35-atmospheres pressure, was constructed at the Podol'sk Plant imeni Ordzhonikidze. It was completely standardized in the heating chamber, and in dimensions of the rear surfaces. In converting the boiler from one fuel to another, only the burners and superheater coils have to be changed.

Standardization of the boiler aggregate was accompanied by an increase in economy, mainly, through lowering the temperature of departing gases, achieved by development of the convection surfaces. The overall savings effected by each boiler aggregage during its utilization, amounted to 1.5-3 million rubles.

Standardization is being widely applied in the manufacture of industrial boilers. For portable boilers of the TsKTI system, DKV type, having a productivity of 2.4- and 6.5-tons-per-hour productivity, there is a single grouping system. For those of 2- to 4-tons-per-hour productivity, each group has the same geometric transverse cross-section, so that the screen tubes and convection tubes, the mounting, and a number of other elements, are identical for each group, while the steam drums of different type-sizes have the same diameter and fittings, differing in length only.

Basic elements of fuel-processing equipment have also been standardized. For example, shaft pulverizers for lignite, milled peat, and shale, made in the Komega Plant, and produced in seven type-sizes ranging in productivity from 1.5-20 tons of pulverized fuel per hour, have a considerable number of common parts.

Ball drum mills made at the Novo-Kramatorsk Plant imeni Stalin, come in eight type-sizes, differing one from the other only in the size of the air-intake opening and the aeromixture outlet.

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Standardization has been applied to chain grates, grates with stoking plates, semimechanical grates, raw-coal feeders, pulverized-coal feeders, cyclone blowers, slit and pipe burners.

Much work has been done to develop a successful apparatus for the automatic control of power equipment. A single electromechanical system is now in effect. The systems are completely standardized, differing only in gauges. The apparatus is so designed that it may be used to regulate burners, feeders, and the temperature of superheater steam. It may also be used to automatically control reduction-cooling units, deaerators, fuel pulverizing equipment, and so forth.

Work is now going on toward developing standards for tubular air preheaters, shaft mills, chain grates, screw and tray type feeders for raw and pulverized coal, water economizers, pipe flanges, and other items.

Standardization in the metallurgical machine-building industry is a more difficult problem, in view of the extremely great diversity of machines. In recent years, however, great advances have been made, and can be seen in the case of rolling-mill equipment manufacture, the most labor-consuming and exacting phase in the field.

The most important factors in speeding up the output of rolling equipment are, first, specialization by the design bureaus and the producing plants; second, subsidiary efforts of smaller plants in aiding the main plants responsible for design and delivery of the mills, by supplying them with separate units needed for the mills' completion; and third, the introduction of advanced technology and application of standardization to units and individual parts.

Increased production and curtailment of the production cycle may be seen in the following cases. Before the war, it took the Novo-Kramatorsk Plant imeni Stalin 2-2½ years to complete a blooming mill. In the postwar period, thanks to the extensive cooperation of a number of plants of the ministry, the cycle was cut more than 50 percent.

Even more remarkable was the achievement of the Uralmash Plant in producing the first rail structural mill for the Novo-Tagil' Metallurgical Plant. The entire manufacturing cycle for this most complex aggregate, weighing over 17,000 tons, from start of production to entry into operation, was only a little over 1½ years

Cooperative specializing among the plants resulted in the production of a large number of mills, at the same time helping to institute some degree of standardization of equipment.

When designing machines which have the same purpose, but which differ in basic parameters (productivity, load capacity, etc), the technical plans are not drawn up until parameters are established (taking into account existing norms and standards) most suitable for standardization of units and parts, and the kinematic systems of the mechanisms have been designated according to type. In doing this, standardized series of units and parts set by norm are used to the maximum degree. Reduction units, clutches, bearings, and so forth, fall into this class.

Aggregates which are old, but not obsolete, are sometimes adapted to standardized units, such as motors, reduction gears, frames, and rollers for the roller conveyers.

In the effort to extend standardization in all plants, units in common use, such as reduction gears, clutches and brakes are being made in conformity with norms.

The models 400, 300, and 140 pipe-rolling aggregates, built at the Uralmash Plant, are a good example of how standardization was applied in planning. Hot-reeling mills and reduction mills in these aggregates are made up of completely identical stands, with the mills differing only in the number of stands. Extensive standardization of certain mechanisms of piercing mills and reeling mills, as well as of roller conveyers, was also carried out.

Large steps forward have been made in standardization of metallurgical and other heavy equipment at the Novo-Kramatorsk Plant imeni Stalin, in Kramatorsk. The plant produces seven type-sizes of hoisting machines for mines. All seven have the same type reduction gear, depth indicator, brake control, springs, and clutches. Complete standardization, excluding the drums and main rotors, was attained in three type-sizes. For the two-drum hoists having 5- and 6-meter drum diameters, six units out of eleven were completely standardized, as well as several complex parts.

In recent years, the plant developed a series of forging machines of 800-3,000-tons capacity. In these machines such complex units as clutches, penumatic control devices, brake controls, and lubrication systems were standardized. A number of separate, complex parts of these machines were also standardized, and these same parts went into 80-95 percent of the forge presses of 1,500-2,500-tons capacity made at the plant.

The plant has standardized basic units for hydraulic machinery, in spite of the individual character of these machines. This has made it possible to reduce the number of type-sizes. For machines of 50-100-tons lifting capacity, for example, reduction gears of two type-sizes were reduced to one type-size; gear clutches of three type-sizes to two; elastic clutches of two type-sizes to one; sprocket chains of two type-sizes to one. For machines of 200-tons lifting capacity, sprocket chains of three type-sizes were reduced to one type-size; reduction gears of three type-sizes were reduced to two.

The number of type-sizes of separate units was reduced for all machines of 50-330-tons lifting capacity: for sprocket chains there was a 50-percent reduction; for reduction gears it was 25 percent; for gear clutches, 20 percent; for elastic clutches, 40 percent; for rack stoppers, 30 percent.

The plant achieved substantial results in standardizing rolling equipment. Up to 50 percent of the units and parts going into the construction of a pipe-billet mill for the Plant imeni Dzerzhinskiy were standardized with those of a pipe-billet mill made for the Zakavkazkiy Plant. This amounted to 4,800 tons of standardized parts and units. A 1,500-ton capacity hot-bloom cutter was 90 percent standardized with a similar one of 1,000-tons capacity.

The Staro-Kramatorsk Plant imeni Ordzhonikidze has done much work in standardizing adjusting machines. It has developed a number of basic machines, embracing 47 type-sizes: cold-sheet cutters, hot-metal cutters, roller-type plate-straightening and section-straightening machines, sheet-bending rollers, helical pipe-straightening and bar-straightening machines, and disk saws. The number of type-sizes of these adjusting machines was reduced 20 percent, and there was extensive standardization of separate parts and units. For example, the 11-roller and 17-roller plate-straightening machines for 1.5 x 1,500-millimeter sheets have about 70 percent identical parts and units, including reduction mechanisms, spindles, and compressor devices.

Individual production takes on series-production aspects when there is an integration into production of identical parts for different machines, as well as similar application of nonidentical parts having the same technological type. The number of identical parts used, and the extent of the series, both depend on the degree to which standardization has been applied in designing the parts and units of the different machines.

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The system of producing groups of identical parts and of nonidentical parts of a single technological type for different machines has been most successfully applied at the Uralmash Plant, where the term "group output" originated. It is normally applied to subsidiary units: bearings, oil pumps, filters, condensers, and similar items. Under the group method, not only does the degree of interchangeablility of parts and units increase, but the expenditure of metal per unit of manufacture is curtailed. Application of the principles of series production in individual machine building makes possible broader application of combination machine tools, molding machines, stamping and broaching machines.

Prewar production of lift and transport machinery was mainly small series while a number of the machines were individually produced; standardization in this branch of machine building did not exist in practice. During the postwar Five-Year Plan steps were taken to raise the lagging output and to improve the design of lift and transport machinery. The entire system of planning and production was altered; parts were now designed in standardized groups, and narrow specialization of individual plants, and broader cooperation among plants were instituted.

In recent years, standardization has been applied in production of a series of overhead travelling cranes, boom cranes, and portal cranes; also in electric hoists, trolleys, belt conveyers, winches, and hand-operated hoists. In implementing this production of standardized machine series, complex series of reduction units, brakes, clutches, axle boxes, traversing wheels, crane suspensions, cabs, transmissions, and other items were developed. There are now 53 All-Union standards and a considerable number of departmental norms for individual parts and units of lift and transport machines. The initiator and leader in applying standardization principles to the industry is the All-Union Scientific-Research Institute for Lift- and Transport-Machine Building.

A series of electric overhead travelling cranes, ranging from 5 to 125-tons capacity, developed by the institute has 46 trolleys. These trolleys are made up of units which are interchangeable with those of five basic models. Thus, the basic model of the trolley for the 5-ton cranes is standard for all modifications of the 5-ton crane trolley; the 10-ton crane trolley is standard for those of the 10- and 20-ton cranes, and for trolleys of special cranes (magnetic and grab) of 5-15 tons capacity; the 30-ton crane trolley is standard for regular 30-ton cranes, and for grab cranes of 20-tons capacity; the trolley of the 50-ton crane is standard for 50- and 75-ton cranes; and the 100-ton crane trolley is standard for the trolleys on the 100- and 125-ton capacity units.

As basic models for cranes within a limited range of lifting capacity, cranes were selected which had the most characteristics in common with other cranes of each range.

As a result of standardizing the design of 42 type-sizes of trolleys for overhead travelling cranes, the trolleys were equipped with only three type-sizes of cable, three diameters of drums, three type-sizes of reduction gears, three sizes of brakes, 15 type-sizes of pinions pairs, three type-sizes of traversing mechanisms, three type-sizes of traversing wheels and axle boxes. Each of the crane trolleys differs from the others coming under its own group (determined by one of the five basic models) only in the size of the frames and the grouping arrangement of the component units.

The bridges of the cranes themselves consist of standardized elements, such as girder cross-sections, and ladders. Two type-sizes of cabs were sufficient to equip the whole series of cranes.

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Standardization of overhead travelling cranes has been most extensively applied at the Novo-Kramatorsk Plant imeni Stalin In Elektrostal'. In a series of foundry cranes ranging from 125-350-tons capacity, the changes in lifting capacity will be made possible by merely changing the number of blocks of the hoist mechanisms, and changes in the lifting speed will be made by minor changes in the size of the cable and the power of the motors.

Another example of far-reaching standardization is seen in a series of telphers developed by the All-Union Scientific-Research Institute for Lift- and Transport-Machine Building. The telphers of this series ranging from 0.5-5-tons capacity, are made up of elements which are identical with those of three basic models.

The group design principle has been applied in an effort to standardize telpher production. The production of these machines was of particular importance as the prewar output of them had been insufficient to meet industrial needs. Work in this field led to standardization in the production of suspended-beam overhead travelling cranes having monorail trolleys equipped with grab buckets, electromagnets, and shovels.

In the construction of portal cranes of 3-15-tons capacity, units and parts of standardized bridge cranes are used.

The Soyzprommekhanizatsiya Trust has applied standardization in developing belt conveyers having belt widths of 400-1,600 millimeters, and belt speeds of one-2.5 meters per second.

As a result of modernization and broad standardization in the construction of cranes and other lift and transport machinery, weight and dimensions have been reduced, and less labor is required in their manufacture. The labor required to produce overhead travelling cranes has been cut at least 20 percent.

When new Diesel engines are designed, they are designated according to type. On the basis of one type, an entire series will be built, with the individual engines of the series differing, mainly, only in the number of cylinders. By designing the motors in conformity with types, plants are enabled to specialize, with each one producing a single standardized series.

In the Ruskiy Dizel' Plant, for example, the design for the type D-30/50 motor answers the construction demands of motors having 320, 400, 500, 600, 800, and 1,000 horsepower in aggregate. In the Plant imeni Mikoyan, on the basis of the single design of the type Ch 10.5/13, motors of 10, 20, 40, and 60 horsepower were made. In the Dvigatel' Revolyutsii Plant, motors of the Ch 23/30 types, having an aggregate capacity of 450 and 600 horsepower, can serve as a basis for the manufacture 300- and 900-horsepower motors. Within each series all basic parts and units, such as pistons, connecting rods, cylinder sleeves, cylinder end caps, distributors, and fuel-supply devices, are interchangeable and standardized.

In line with the creation of standardized motor series, there will be a development of standardized units and parts common to machines of different series.

The Scientific-Research Diesel Institute has worked out a project for standardizing reversing reduction clutches for Diesels of 10-600 horsepower. At present, clutches for motors of 10 and 20 horsepower and 450-600 horsepower are made. Work is being carried out in standardizing fuel apparatus, governors, and oil coolers.

Facing the Diesel industry is the task of broadening the assortment of standardized parts, such as oil pumps, oil filters, water pumps, and automatic control devices which can go into the construction of motors of different horsepower within the same series.

Type designation and standardization in the machine-building field insures an increase in both the volume of production and in the quality of the product. Its effect has been observed in the shortening of the production cycle in the manufacture of such aggregates as steam turbines, high-capacity boilers, and heavy crushers, and in the reduction of labor expended per unit of production. Standardization also leads to reduction of the production-preparation cycle, and of the production costs.

There are, however, still some considerable problems to be resolved in the field of standardization and type designation. Coordination among individual plants, institutes, and ministries is important. Scientific institutes should play a large role in developing parameters for type-sizes of machines and units, main systems of machines, methods of standardization, and general methods of computation.

At present, there is no single method of computing the degree to which designs have been standardized. There are estimates by weight, by number of parts, by reduction of labor expenditure, by reduction in the number of blueprints required, by curtailment of the number of new models, by reduction of the weight of the machines, and by reductions in the cost of production. The absence of a unified, official methodology, written into law, for estimating the effectiveness and extent of standardization, prevents the attainment of comparable results in the estimates made by different enterprises and organizations. The time has come for our research organizations to resolve the situation.

Series production of machines by any ministry or department whatsoever, should not be permitted except with approval of the ministry responsible for the nomenclature of such machines. In case two or more ministries should find themselves running parallel in establishing nomenclature, then the ministry having final authority for the given type of machine should be determined by the Gostekhnika (State Committee of the Council of Ministers USSR for the Introduction of Advanced Technical Development into the National Economy).

Such priority control should liquidate parallelism in the designing of new machines, and make it possible to reduce the number of type-sizes of these machines.

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